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INTRODUCTION

Depending on the chemical composition structural steels are divided into two main groups:

1. Carbon steels.

2. Alloy steels containing special additions of alloying elements (chromium, nickel, molybdenum, tungsten, vanadium, and others) or having high silicon content (over 1.0%) or manganese (over 1.0 1.5%).

The structural carbon steels in their turn are divided into steels of commercial quality and high grade steels, while structural alloy steels are divided into high grade steels and extra high grade steels.

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HOT ROLLED COMMERCIAL QUALITY CARBON STEEL

Hot rolled commercial quality structural carbon steel is used for manufacturing of building structures, bridges, reinforcement, rivets, ordinary duty fire box equipment etc. Structural carbon steel containing 0.1 to 0.2 per cent of carbon is mostly used without any heat treatment for manufacturing engineering constructions, bridge trusses, building frameworks, etc. The structural carbon steel should comply with the following basic requirements: strength, good ductility and good weldability.

The low-carbon hardened steel is used in machine-building for manufacturing of different parts of higher strength.

Hot rolled commercial quality carbon steel is manufactured and delivered in accordance with the requirements of the USSR Standard ГОСТ 380-50.

Depending on characteristics of metal quality guaranteed in time of delivery the hot rolled commercial quality carbon steel is divided into two groups:

Group A - steel to be supplied according to physical properties. As a rule steel of group A is ordered in those cases when it is used in the state of delivery.

Group B - steel to be supplied according to chemical analysis. As a rule steel of group B is subjected by the purchaser to hot mechanical working or to heat treatment.

Steel of group A is divided into the following grades: Ст. 0, Ст. 1, Ст. 2, Ст. 3, Ст. 4, Ст. 5, Ст. 6 and Ст. 7.

Steel of group B is divided into the following grades: open hearth steels МСт. 0, МСт. 1, МСт. 2, МСт. 3, МСт. 4, МСт. 5, МСт. 6 and МСт. 7; acid Bessemer steels БСт. 0, БСт. 3, БСт. 4, БСт. 5 and БСт. 6.

Steel of group A is delivered with the following physical properties (Table 1).

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Table 1

Grade of steel	Tensile strength, σ_b kg sq.mm	Elongation, % for long test specimen $\delta = 10\%$ minimum	Elongation, % for short test specimen $\delta = 5\%$ minimum	Yield point, σ_s kg sq.mm
Ст. 0	34 47	18	22	19
Ст. 1	32 40	28	33	
Ст. 2	34 42	26	31	22
Ст. 3	38 40	23	27	24
	41 43	22	26	
	44 47	21	25	
Ст. 4	42 44	21	25	26
	45 48	20	24	
	49 52	19	23	
Ст. 5	50 53	17	21	28
	54 57	16	20	
	58 62	15	19	
Ст. 6	60 63	13	15	31
	64 67	12	14	
	68 72	11	13	
Ст. 7	70 74	9	11	
	75 79	8	10	
	80 and over	7	9	

Standard limits of tensile strength, elongation and yield point shown in Table 1 are applied to rolled steel -- round, square, flats and rolled steel shapes in thickness of 8 to 40 mm; and to sheet steel and wide strip steel in thickness of 8 to 30 mm.

The test limits for bend testing in a cold condition are applied to all kinds of rolled steel products in thickness of 2 to 25 mm.

When hot rolled steel of group A is delivered with a guarantee of limitations for carbon, sulphur and phosphorus the maximum content of these elements should correspond to the standard limits indicated in the table of chemical composition for corresponding steel grades supplied according to group B.

When steel for welded structures is ordered according to steel grades of group A, the purchaser may request a guarantee for carbon content not to exceed the limits for corresponding steel grades of group B.

For steels of group B the guaranteed characteristic of the quality is the chemical composition shown in Table 2.

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Table 2

Grade of steel	Chemical composition, %							
	Carbon		Manganese		Silicon		Sulphur	Phosphorus
					Rimmed steel	Killed and semi-killed steel	Maximum	
Open-hearth steels								
МСт. 0	up to 0.23						0.060	0.070
МСт. 1	0.07	0.12	0.35	0.50	traces		0.055	0.050
МСт. 2	0.09	0.15	0.35	0.50	-	0.12 0.30	0.055	0.050
МСт. 3	0.14	0.22	0.40	0.65	-	0.12 0.30	0.055	0.050
МСт. 4	0.18	0.27	0.40	0.70		0.17 0.35	0.055	0.050
МСт. 5	0.28	0.37	0.50	0.80		0.17 0.35	0.055	0.050
МСт. 6	0.38	0.50	0.50	0.80		0.17 0.35	0.055	0.050
МСт. 7	0.50	0.63	0.55	0.85				
Acid Bessemer steels								
БСт. 0	up to 0.14						0.070	0.080
БСт. 3	up to 0.12		0.25	0.55	traces	0.10 0.25	0.065	0.065
БСт. 4	0.12	0.20	0.35	0.55		0.10 0.25	0.065	0.065
БСт. 5	0.17	0.30	0.50	0.80		0.10 0.25	0.065	0.065
БСт. 6	0.26	0.40	0.60	0.90		0.10 0.25	0.065	0.065

As a rule steel grades Ст. 1, Ст. 2 and Ст. 3 are used for different constructional purposes and steel structures and also for ordinary duty machine parts without heat treatment.

Steel grades Ст. 4, Ст. 5 and Ст. 6 are used in machine building industry for manufacturing of machine and mechanism parts: shafts, axles, etc.

Steel grade Ст. 7 is used for manufacturing of leaf and coil springs, ordinary duty tools such as: sledge hammers, chisels, axes, saws, etc.

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HIGH GRADE STRUCTURAL CARBON STEEL

High grade structural carbon steel is made and delivered in accordance with the USSR Standard FOCT 1050-52.

Depending on the chemical composition high grade structural carbon steel is divided into two groups: (I) with normal and (II) with increased manganese content as shown in Table 3.

Table 3

Grade of steel	Chemical composition, %									
	Carbon		Manganese		Silicon		Sulphur	Phosphorus	Nickel	Chromium
							maximum			
I. Group of steels with normal manganese content										
05 кп	up to 0.06		up to 0.35		up to 0.03		0.040	0.040	0.30	0.15
05	up to 0.05		up to 0.20		up to 0.20		0.030	0.025	traces	traces
08 кп	0.05	0.12	0.25	0.50	up to 0.03		0.040	0.040	0.30	0.15
10	0.07	0.15	0.35	0.65	0.17	0.37	0.045	0.040	0.30	0.15
15	0.12	0.20	0.35	0.65	0.17	0.37	0.045	0.040	0.30	0.30
20	0.17	0.25	0.35	0.65	0.17	0.37	0.045	0.040	0.30	0.30
25	0.22	0.30	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
30	0.27	0.35	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
35	0.32	0.40	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
40	0.37	0.45	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
45	0.42	0.50	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
50	0.47	0.55	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
55	0.50	0.60	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
60	0.55	0.65	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
65	0.60	0.70	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
70	0.65	0.75	0.50	0.80	0.17	0.37	0.045	0.040	0.30	0.30
II. Group of steels with increased manganese content										
15 Г	0.12	0.20	0.70	1.00	0.17	0.37	0.045	0.040	0.30	0.30
20 Г	0.17	0.25	0.70	1.00	0.17	0.37	0.045	0.040	0.30	0.30
30 Г	0.25	0.35	0.70	1.00	0.17	0.37	0.045	0.040	0.30	0.30
40 Г	0.35	0.45	0.70	1.00	0.17	0.37	0.045	0.040	0.30	0.30
50 Г	0.45	0.55	0.70	1.00	0.17	0.37	0.045	0.040	0.30	0.30

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Grade of steel	Chemical composition, %									
	Carbon		Manganese		Silicon		Sulphur	Phosphorus	Nickel	Chromium
							maximum			
60 Г	0.55	0.65	0.70	1.00	0.17	0.37	0.045	0.040	0.30	0.30
65 Г	0.60	0.70	0.9	1.20	0.17	0.37	0.045	0.040	0.30	0.30
70 Г	0.65	0.75	0.9	1.20	0.17	0.37	0.045	0.040	0.30	0.30
10 Г2	0.07	0.15	1.2	1.60	0.17	0.37	0.045	0.040	0.30	0.30
30 Г2	0.25	0.35	1.4	1.80	0.17	0.37	0.045	0.040	0.30	0.30
35 Г2	0.30	0.40	1.4	1.80	0.17	0.37	0.045	0.040	0.30	0.30
40 Г2	0.35	0.45	1.4	1.80	0.17	0.37	0.045	0.040	0.30	0.30
45 Г2	0.40	0.50	1.4	1.80	0.17	0.37	0.045	0.040	0.30	0.30
50 Г2	0.45	0.55	1.4	1.80	0.17	0.37	0.045	0.040	0.30	0.30

High grade structural carbon steel is produced by either of the following processes: basic or acid open hearth or electric arc furnaces.

As a rule steel is supplied in hot rolled state (non-annealed). At the purchaser's request steel can be delivered heat treated — annealed, high tempered or normalized.

For production of patented wire the following grades of steel are available: grades 40, 45, 50, 55, 60, 65 and 70 with manganese content from 0.30 to 0.60 per cent and grade 65 Г with manganese content from 0.70 to 1.00 per cent, the residual content of nickel and chromium not exceeding 0.12 per cent of each element.

At the purchaser's request the supplier can furnish the select steel with a carbon content range narrower than that specified in Table 3, with a minimum difference between the upper and lower limits of the carbon content of not less than 0.05 per cent.

As to the shape, dimensions of cross section, length and camber the structural carbon steel shall comply with the limits of corresponding standards for assortment.

The surfaces of steel bars and rods intended for hot mechanical working and also for cold drawing (semi-finished) shall be free from cracks, scale, laps, non-metallic inclusions and hair cracks.

The macrostructure of steel, when examined by the naked eye is characterized by the freedom from signs of piping, bubbles, lamination, cracks, slag inclusions and flakes.

High grade structural carbon steels intended for cold mechanical working shall have a determined hardness conforming to the specification shown in Table 4.

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Table 4

Grade of steel	Hot rolled steels		Annealed steels	
	Dia of impression, *mm*, minimum	Brinell hardness number, maximum	Dia of impression, *mm*, minimum	Brinell hardness number, maximum
		Group I		
08 kp	5.2	131		
10	5.1	137		
15	5.0	143		
20	4.8	156		
25	4.6	170		
30	4.5	179		
35	4.4	187		
40	4.1	217	4.3	197
45	3.9	241	4.2	207
50	3.9	241	4.1	217
55	3.8	255	4.0	229
60	3.8	255	4.0	229
65	3.8	255	4.0	229
70	3.7	269	4.0	229
		Group II		
15 Г	4.7	163		
20 Г	4.3	197		
30 Г	4.1	217	4.4	187
40 Г	4.0	229	4.2	207
50 Г	3.8	255	4.0	229
60 Г	3.7	269	4.0	229
65 Г	3.7	269	4.0	229
70 Г	3.7	269	4.0	229
10 Г2	4.3	197		
30 Г2	3.9	241	4.2	207
35 Г2	3.9	241	4.2	207
40 Г2	3.8	255	4.1	217
45 Г2	3.7	269	4.0	229
50 Г2	3.7	269	4.0	229

The physical properties of high grade structural carbon steel of diameters or thickness up to and including 80 *mm* when tested on tension test specimens prepared from normalized blanks shall correspond to the standard limits shown in Table 5.

At the purchaser's request structural carbon bar steel shall be subjected to impact ductility test on heat treated test specimens.

Steel subjected to impact ductility test is marked with a letter "У."

The results of impact ductility test shall conform to the standard limits shown in Table 6.

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Table 5

Grade of steel	Tensile strength, kg sq.mm	Yield point, kg sq.mm	Elongation, % minimum	Reduction of area, %
		Group I		
08 кп	32	18	33	60
10	34	21	31	55
15	37	22	27	55
20	41	25	25	55
25	44	26	23	50
30	48	29	21	50
35	52	31	20	45
40	57	32	19	45
45	60	34	16	40
50	63	35	14	40
55	64	36	12	35
60	65	37	10	35
65	66	38	10	30
70	67	39	8	30
		Group II		
15 Г	40	23	24	55
20 Г	43	25	22	50
30 Г	55	29	15	45
40 Г	60	33	14	45
50 Г	65	37	11	40
60 Г	70	38	9	35
65 Г	75	40	8	35
70 Г	80	42	7	30
10 Г2	43	25	22	50
30 Г2	69	35	15	45
35 Г2	63	37	13	40
40 Г2	67	39	12	40
45 Г2	70	41	11	40
50 Г2	75	43	10	35

Table 6

Grade of steel	Heat treatment: Temperature of quenching, in °C (approx.)	Heat treatment: Quenching medium	Heat treatment: Temperature of tempering, in °C (approx.)	Impact ductility kgm sq.cm minimum
30 У	890	Water	600	8
35 У	880	Water	600	7
40 У	860	Water	600	5
45 У	850	Water	600	5
50 У	840	Water	600	4
50 ГУ	850	Oil	600	4

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STRUCTURAL ALLOY STEELS

The structural alloy steel is delivered in conformity with specified limits of the USSR Standard ГОСТ 4543-48.

Depending on chemical composition and physical properties the structural alloy bar steel is divided into high grade structural alloy steel and extra high grade structural alloy steel (see Table 7).

The sulphur and phosphorus content shall not exceed 0.04 per cent of each element in high grade steel, while in extra high grade steel the sulphur content shall be up to 0.030 per cent and phosphorus — up to 0.035 per cent.

According to the requirements of the purchaser's order structural alloy steels can be delivered either heat treated — annealed, normalized or high tempered, or without heat treatment.

As to the shape and dimensions the steel shall be delivered in accordance with the assortment specified in the corresponding USSR Standards.

The outside surfaces of steel bars and rods intended for hot mechanical working and also for cold drawing (semi-finished) shall be free from cracks, scale, non-metallic inclusions, laps and hair cracks.

The dimensional tolerances of the steel intended for cold heading are determined from the nominal diameter or thickness of steel bars.

Local defects on the outside surface of steel bars intended for cold mechanical working (turning, planning, etc.) are allowed provided that their depth shall not exceed for bars of 80 *mm* and over in diameter or thickness, the specified tolerances for a given size, and for bars under 80 *mm* — one half of the tolerance for the specified dimension, as determined from the nominal diameter or thickness of steel bars.

The purchaser shall indicate in the order the purpose for which the steel is intended.

Steel intended for hot upsetting and stamping shall be subjected to a hot upsetting test. Steel bars up to 30 *mm* in diameter or thickness intended for cold heading are subjected to cold heading test.

The macrostructure of steel when examined on the fractured and etched templates shall be free from signs of piping, bubbles, laminations, cracks, non-metallic inclusions and flakes.

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Table 7

Group of steel	Grade of steel	Chemical composition, %													
		Carbon		Silicon		Manganese		Chromium		Nickel	Tungsten	Vanadium		Molybdenum		Aluminium	Titanium
High grade steels																	
Chrome	15X	0.12	0.20	0.17	0.37	0.30	0.60	0.70	1.00	up to 0.40							
	20X	0.15	0.25	0.17	0.37	0.50	0.80	0.70	1.00	up to 0.40							
	30X	0.25	0.35	0.17	0.37	0.50	0.80	0.80	1.10	up to 0.40							
	35X	0.30	0.40	0.17	0.37	0.50	0.80	0.80	1.10	up to 0.40							
	40X	0.35	0.45	0.17	0.37	0.50	0.80	0.80	1.10	up to 0.40							
	45X	0.40	0.50	0.17	0.37	0.50	0.80	0.80	1.10	up to 0.40							
	50X	0.45	0.55	0.17	0.37	0.50	0.80	0.80	1.10	up to 0.40							
Chrome-Vanadium	15XФ	0.12	0.20	0.17	0.37	0.30	0.60	0.80	1.10	up to 0.40		0.10	0.20				
	20XФ	0.15	0.25	0.17	0.37	0.40	0.70	0.80	1.10	up to 0.40		0.10	0.20				
Molybdenum	15M	0.10	0.18	0.17	0.37	0.40	0.70	-	0.30	up to 0.30				0.40	0.55		
	20M	0.15	0.25	0.17	0.37	0.40	0.70	-	0.30	up to 0.30				0.40	0.55		
	30M	0.25	0.35	0.17	0.37	0.50	0.80	-	0.30	up to 0.40				0.40	0.55		
Chrome-Molybdenum	12XM	up to 0.16		0.17	0.37	0.40	0.70	0.80	1.10	up to 0.30				0.40	0.55		
	20XM	0.15	0.25	0.17	0.37	0.40	0.70	0.80	1.10	up to 0.40				0.15	0.25		
	30XM	0.25	0.35	0.17	0.37	0.40	0.70	0.80	1.10	up to 0.40				0.15	0.25		
	35XM	0.30	0.40	0.17	0.37	0.40	0.70	0.80	1.10	up to 0.40				0.15	0.25		
Chrome-Silicon	33XC	0.29	0.37	1.00	1.30	0.30	0.60	1.30	1.60	up to 0.40							
	37XC (40C'X)	0.32	0.42	1.00	1.30	0.30	0.60	1.30	1.60	up to 0.40							
	40C'X	0.37	0.45	1.20	1.60	0.30	0.60	1.30	1.60	up to 0.40							
Chrome-Manganese	15XГ	0.12	0.20	0.17	0.37	1.10	1.40	0.40	0.70	up to 0.40							
	20XГ	0.15	0.25	0.17	0.37	0.90	1.20	0.90	1.20	up to 0.40							
	40XГ	0.35	0.45	0.17	0.37	0.90	1.20	0.90	1.20	up to 0.40							
	35XГ2	0.30	0.40	0.17	0.37	1.60	1.90	0.40	0.70	up to 0.40							

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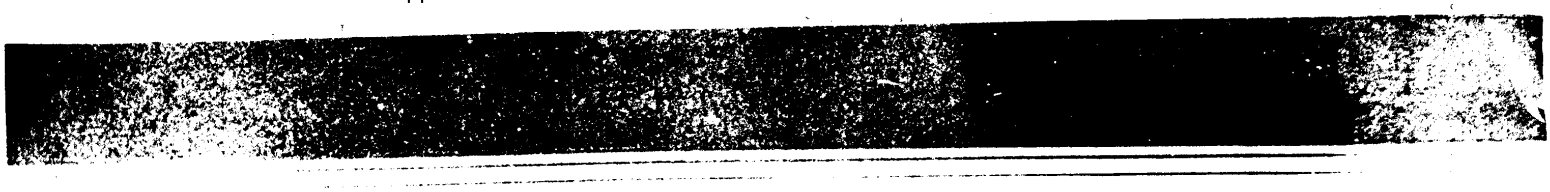

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Group of steel	Grade of steel	Chemical composition, %															
		Carbon		Silicon		Manganese		Chromium		Nickel		Tungsten	Vanadium	Molybdenum		Aluminium	Titanium
Chrome-Manganese-Titanium	18ХГТ	0.16	0.24	0.17	0.37	0.80	1.10	1.00	1.30	up to 0.40							0.06 0.15
Chrome-Manganese-Molybdenum	18ХГМ	0.16	0.24	0.17	0.37	0.90	1.20	0.90	1.20	up to 0.40				0.20	0.30		
	40ХГМ (38ХГМ)	0.37	0.45	0.17	0.37	0.90	1.20	0.90	1.20	up to 0.40				0.20	0.30		
Silicon-Manganese	27СГ	0.22	0.32	1.10	1.40	1.10	1.40	up to 0.30		up to 0.40							
	35СГ	0.30	0.40	1.10	1.40	1.10	1.40	up to 0.30		up to 0.40							
Chrome-Silicon-Manganese	20ХГС	0.15	0.25	0.90	1.20	0.80	1.10	0.80	1.10	up to 0.40							
	25ХГС	0.22	0.30	0.90	1.20	0.80	1.10	0.80	1.10	up to 0.40							
	30ХГС	0.25	0.35	0.90	1.20	0.80	1.10	0.80	1.10	up to 0.40							
	35ХГС	0.30	0.40	1.10	1.40	0.80	1.10	1.10	1.40	up to 0.40							
Nickel	25Н	0.20	0.30	0.17	0.37	0.50	0.80	up to 0.30		0.50	0.90						
	30Н	0.25	0.35	0.17	0.37	0.50	0.80	up to 0.30		0.80	1.20						
Nickel-Molybdenum	15НМ	0.10	0.18	0.17	0.37	0.40	0.70	up to 0.30		1.50	1.20			0.20	0.30		
	20НМ	0.17	0.25	0.17	0.37	0.40	0.70	up to 0.30		1.50	1.20			0.20	0.30		
	40НМ	0.37	0.45	0.17	0.37	0.40	0.70	up to 0.30		1.50	1.20			0.20	0.30		
Chrome-Nickel	20ХН	0.15	0.25	0.17	0.37	0.40	0.70	0.45	0.75	1.00	1.50						
	40ХН	0.35	0.45	0.17	0.37	0.50	0.80	0.45	0.75	1.00	1.50						
	45ХН	0.40	0.50	0.17	0.37	0.50	0.80	0.45	0.75	1.00	1.50						
	50ХН	0.45	0.55	0.17	0.37	0.50	0.80	0.45	0.75	1.00	1.50						
	12ХН2	up to	0.17	0.17	0.37	0.30	0.60	0.60	0.90	1.50	2.00						

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Cont.

Group of steel	Grade of steel	Chemical composition, %									
		Carbon	Silicon	Manganese	Chromium	Nickel	Tungsten	Vanadium	Molybdenum	Aluminium	Titanium
Chrome-Nickel	12XH3	up to 0.17	0.17–0.37	0.30–0.60	0.60–0.90	2.75–3.25	–				
	30XH3	0.25–0.35	0.17–0.37	0.30–0.60	0.60–0.90	2.75–3.25	–				
	12X2H4	up to 0.17	0.17–0.37	0.30–0.60	1.25–1.75	3.25–3.75	–				
	20X2H4	0.15–0.22	0.17–0.37	0.30–0.60	1.25–1.75	3.25–3.75	–	–	–	–	
		Extra high grade steels									
Chrome	15XA	0.12–0.18	0.17–0.37	0.30–0.60	0.70–1.00	up to 0.40	–	–	–		
	20XA	0.17–0.24	0.17–0.37	0.50–0.80	0.70–1.00	up to 0.40	–	–	–		
	30XA	0.25–0.33	0.17–0.37	0.50–0.80	0.80–1.10	up to 0.40	–	–			
	38XA	0.34–0.42	0.17–0.37	0.50–0.80	0.80–1.10	up to 0.40	–	–			
	45XA	0.42–0.50	0.17–0.37	0.50–0.80	0.80–1.10	up to 0.40					
	50XA	0.47–0.55	0.17–0.37	0.50–0.80	0.80–1.10	up to 0.40					
Chrome-Vanadium	15XΦA	0.12–0.18	0.17–0.37	0.30–0.60	0.80–1.10	up to 0.40		0.10–0.20			
	20XΦA	0.17–0.25	0.17–0.37	0.40–0.70	0.80–1.10	up to 0.40		0.10–0.20			
	40XΦA	0.37–0.45	0.17–0.37	0.50–0.80	0.80–1.10	up to 0.40		0.10–0.20			
	50XΦA	0.46–0.54	0.17–0.37	0.50–0.80	0.80–1.10	up to 0.40		0.10–0.20			
Molybdenum	12MA	0.10–0.16	0.17–0.37	0.40–0.70	up to 0.30	up to 0.30			0.40–0.55		
	20MA	0.17–0.24	0.17–0.37	0.40–0.70	up to 0.30	up to 0.30			0.40–0.55		
	30MA	0.26–0.34	0.17–0.37	0.50–0.80	up to 0.30	up to 0.40			0.40–0.55		
Chrome-Molybdenum	15XMA	0.10–0.18	0.17–0.37	0.40–0.70	0.80–1.10	up to 0.30			0.40–0.55		
	20XMA	0.17–0.24	0.17–0.37	0.40–0.70	0.80–1.10	up to 0.40			0.15–0.25		
	30XMA	0.25–0.33	0.17–0.37	0.40–0.70	0.80–1.10	up to 0.40			0.15–0.25		
	35XMA	0.32–0.40	0.17–0.37	0.40–0.70	0.80–1.10	up to 0.40			0.15–0.25		
	35X2MA	0.32–0.40	0.17–0.37	0.40–0.70	1.60–1.90	up to 0.40			0.15–0.25		

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Cont.

Group of steel	Grade of steel	Chemical composition, %															
		Carbon		Silicon		Manganese		Chromium		Nickel		Tungsten	Vanadium		Molybdenum		Aluminium		Titanium
Chrome-Silicon	33XCA	0.29	0.37	1.03	1.30	0.30	0.60	1.30	1.60	up to	0.40								
	40XCA	0.37	0.45	1.00	1.30	0.30	0.60	1.30	1.60	up to	0.40								
Chrome-Manganese	15XΓA	0.12	0.18	0.17	0.37	1.10	1.40	0.40	0.70	up to	0.40								
	20XΓA	0.18	0.25	0.17	0.37	0.90	1.20	0.90	1.20	up to	0.40								
	40XΓA	0.37	0.45	0.17	0.37	0.90	1.20	0.90	1.20	up to	0.40								
	35XΓ2A	0.32	0.40	0.17	0.37	1.60	1.90	0.40	0.70	up to	0.40								
Chrome-Manganese-Molybdenum	18XΓMA	0.16	0.24	0.17	0.37	0.90	1.20	0.90	1.20	up to	0.40				0.20	0.30			
	40XΓMA	0.37	0.45	0.17	0.37	0.90	1.20	0.90	1.20	up to	0.40				0.20	0.30			
Chrome-Silicon-Manganese	20XΓCA	0.17	0.24	0.90	1.20	0.80	1.10	0.80	1.10	up to	0.40								
	25XΓCA	0.22	0.29	0.90	1.20	0.80	1.10	0.80	1.10	up to	0.40								
	30XΓCA	0.28	0.35	0.90	1.20	0.80	1.10	0.80	1.10	up to	0.40								
	35XΓCA	0.32	0.39	1.10	1.40	0.80	1.10	0.80	1.10	up to	0.40								
Chrome-Aluminium and Chrome-Molybdenum-Aluminium	35XΦA	0.31	0.39	0.17	0.37	0.30	0.60	1.35	1.65	up to	0.40						0.70	1.20	
	38XMΦA	0.35	0.42	0.17	0.37	0.30	0.60	1.35	1.65	up to	0.40				0.15	0.25	0.70	1.10	
Chrome-Molybdenum-Vanadium	35XMΦA	0.30	0.38	0.17	0.37	0.40	0.70	1.00	1.30	up to	0.40		0.10	0.20	0.20	0.30			
	25X2MΦA	0.22	0.29	0.17	0.37	0.40	0.70	1.50	1.80	up to	0.40		0.15	0.30	0.20	0.30			
Nickel	25HA	0.22	0.30	0.17	0.37	0.50	0.80	up to	0.30	0.50	0.90								
	30HA	0.27	0.35	0.17	0.37	0.50	0.80	up to	0.30	0.80	1.20								

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Cont.

Group of steel	Grade of steel	Chemical composition, %									
		Carbon	Silicon	Manganese	Chromium	Nickel	Tungsten	Vanadium	Molybdenum	Aluminium	Titanium
Nickel-Molybdenum	15HMA	up to 0.17	0.17—0.37	0.40—0.70	up to 0.30	1.50—2.00			0.20—0.30		
	40HMA	0.37—0.45	0.17—0.37	0.50—0.80	up to 0.30	1.50—2.00			0.20—0.30		
Chrome-Nickel	20XHA	0.15—0.23	0.17—0.37	0.40—0.70	0.45—0.75	1.00—1.50					
	40XHA	0.37—0.45	0.17—0.37	0.50—0.80	0.45—0.75	1.00—1.50					
	12XH2A	0.11—0.17	0.17—0.37	0.30—0.60	0.60—0.90	1.50—2.00					
	12XH3A	0.11—0.17	0.17—0.37	0.30—0.60	0.60—0.90	2.75—3.25					
	20XH3A	0.17—0.25	0.17—0.37	0.30—0.60	0.60—0.90	2.75—3.25					
	30XH3A	0.27—0.35	0.17—0.37	0.30—0.60	0.60—0.90	2.75—3.25					
	37XH3A	0.33—0.41	0.17—0.37	0.25—0.55	1.20—1.60	3.00—3.50					
	12X2H4A	0.11—0.17	0.17—0.37	0.30—0.60	1.25—1.75	3.25—3.75					
	20X2H4A	0.15—0.22	0.17—0.37	0.30—0.60	1.25—1.75	3.25—3.75					
Chrome-Nickel-Vanadium	20XH4ΦA	0.17—0.24	0.17—0.37	0.25—0.55	0.17—1.10	3.75—4.25		0.15—0.30			
Chrome-Nickel-Tungsten	18XHBA	0.14—0.21	0.17—0.37	0.25—0.55	1.35—1.65	4.00—4.50	0.80—1.20				
	25XHBA	0.21—0.28	0.17—0.37	0.25—0.55	1.35—1.65	4.00—4.50	0.80—1.20				
Chrome-Nickel-Molybdenum	12X2H3MA	0.10—0.17	0.17—0.37	0.30—0.60	1.45—1.75	2.75—3.25			0.20—0.30		
	18X2H4MA	0.15—0.22	0.17—0.37	0.40—0.70	1.45—1.75	3.25—3.75			0.20—0.30		
	33XH3MA	0.29—0.37	0.17—0.37	0.50—0.80	0.80—1.10	2.50—3.00			0.20—0.30		
	40XHMA	0.36—0.44	0.17—0.37	0.50—0.80	0.60—0.90	1.25—1.75			0.15—0.25		
Chrome-Nickel-Molybdenum-Vanadium	30XH2MΦA	0.26—0.33	0.17—0.37	0.30—0.60	0.60—0.90	2.00—2.50		0.15—0.30	0.20—0.30		
	45XHMΦA	0.42—0.50	0.17—0.37	0.30—0.80	0.80—1.10	1.30—1.80		0.10—0.20	0.20—0.30		

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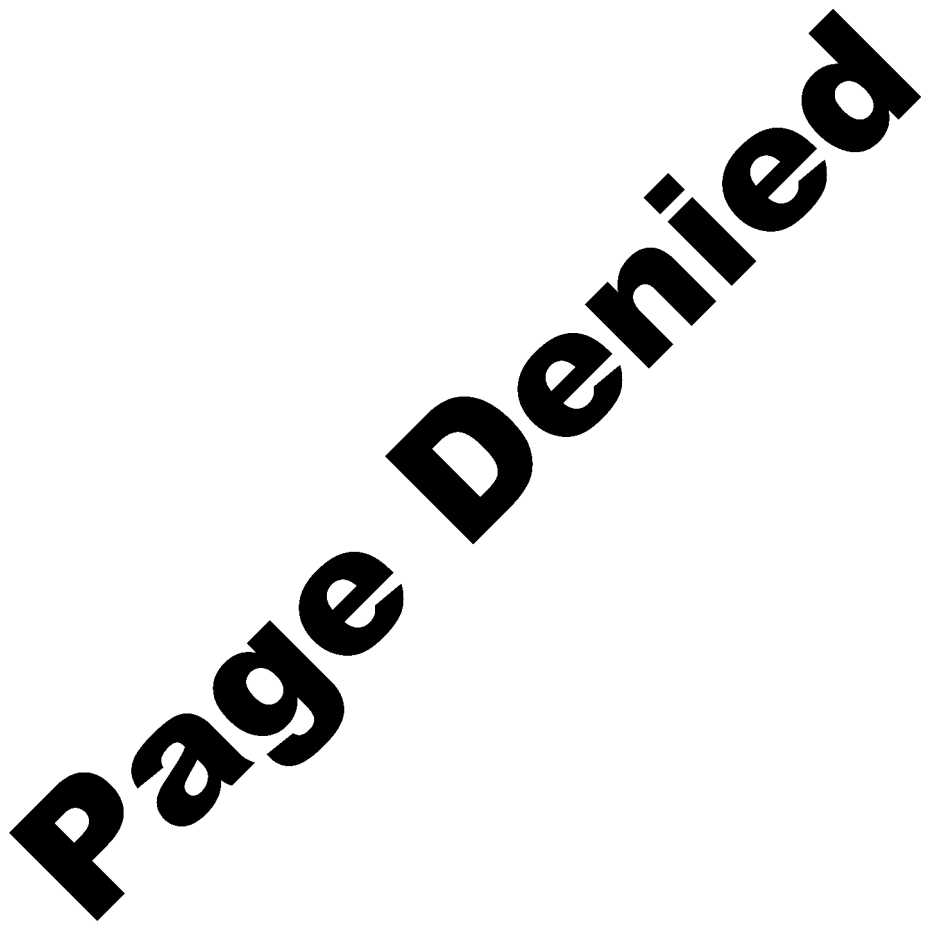

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Cont.

Grade of steel	Heat treatment: Quenching Temperature, °C: First quench	Quenching Temperature, °C: Second quench	Quenching medium	Tempering: Temperature, °C	Tempering: Tempering medium	Physical properties: Tensile strength, σ_b kg sq.mm	Yield point, σ_s kg sq.mm	Elongation, %	Reduction of area, %	Impact ductility, kgm sq.cm
								minimum		
12XH2A	860	780	Oil or water	200	Water or oil	80	60	12	50	9
12XH3	860	780	Oil	150	Water or oil	95	70	10	50	8
12XH3A	860	780	Oil	150	Water or oil	95	70	11	55	9
20XH3A	820		Oil	500	Water or oil	95	75	11	55	10
30XH3A	820		Oil	530	Water or oil	100	80	9	45	8
37XH3A	820		Oil	530	Water or oil	115	100	10	50	6
12X2H4	880	780	Oil	200	Air	110	85	10	50	8
12X2H4A	880	780	Oil	200	Air	110	85	10	50	9
20X2H4	880	780	Oil	200	Air	120	110	9	45	7
20X2H4A	880	780	Oil	200	Air	120	110	9	45	8
20XH4ФA	850		Oil	510	Oil	110	90	10	50	8
18XHBA	950	850	Air	160	Air	115	85	12	50	10
25XHBA	850		Oil	560	Oil	110	95	11	45	9
12X2H3MA	860		Oil	180	Water or oil	100	80	9	50	9
18X2H4MA	950	850	Air	200	Air	115	85	10	45	10
40XHMA	850		Oil	600	Water or oil	100	85	12	55	10
30XH2MФA	860		Oil	680	Water or oil	90	80	10	40	9
45XHMФA	860		Oil	460	Oil	150	135	7	35	4

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Cont.

Grade of steel	Heat treatment: Quenching Temperature, °C First quench	Quenching Temperature, °C Second quench	Quenching medium	Tempering Temperature, °C	Tempering medium	Physical properties: Tensile strength, σ_b kg/sq.mm	Yield point, σ_s kg sq.mm	Elongation, % minimum	Reduction of area, ψ %	Impact ductility, kgm sq.cm
20XГ	860		Oil	180	Air	80	60	12	50	
35XГ2	870		Oil	600	Water	85	70	12	45	8
18XГM	860		Oil	190	Air	110	90	10	50	9
40XГM	850		Oil	600	Water or oil	100	80	10	45	9
27CГ	920		Water	420	Water or oil	100	80	12	40	5
35CГ	900		Water	590	Water	85	65	15	40	6
20XГC	880		Oil	500	Water or oil	80	60	10	40	6
30XГC	880		Oil	520	Water or oil	110	85	10	45	4.5
30XГCA	880		Oil	520	Water or oil	110	85	10	40	5
35XГCA	Isothermic quenching from 800° C in mixture of potassium and sodium nitrate at 280 310° C					165	130	9	40	6
35XΦA	940		Warm water or oil	650	Water or oil	95	75	10	50	8
38XMΦA	940		Warm water or oil	650	Water or oil	100	85	15	50	9
35XMΦA	900		Oil	630	Water or oil	110	95	10	50	9
15HM	860	780	Oil	200	Air	85	65	11	50	8
20XH	840		Water or oil	500	Water or oil	80	60	10	50	8
40XH	820		Oil	500	Water or oil	100	80	10	45	7
45XH	820		Oil	530	Water or oil	100	80	10	45	7
50XH	820		Oil	500	Water or oil	110	85	8	40	5
12XH2	860	780	Oil or water	200	Water or oil	80	60	12	50	8

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Table 9

Grade of steel	Heat treatment: Quenching: Temperature, °C: First quench	Heat treatment: Quenching: Temperature, °C: Second quench	Heat treatment: Quenching: Quenching medium	Heat treatment: Tempering: Temperature, °C	Heat treatment: Tempering: Tempering medium	Physical properties: Tensile strength, σ_b kg sq.mm	Physical properties: Yield point, σ_s kg/sq.mm	Physical properties: Elongation, %	Physical properties: Reduction of area, ψ %	Physical properties: Impact ductility, kgm sq.cm
						minimum				
15X	860	780	Water	200	Air	70	50	10	45	7
15XA	860	780	Water	200	Air	70	50	11	50	8
20X	860		Water or oil	200	Air	80	60	10	40	6
30X	860		Oil	500	Water or oil	90	70	11	45	6
35X	860		Oil	500	Water or oil	95	75	10	45	6
38XA	860		Oil	550	Water or oil	95	80	12	50	9
40X	850		Oil	500	Water or oil	100	80	9	45	6
45X	840		Oil	500	Water or oil	105	85	8	40	5
50X	830		Oil	500	Water or oil	110	90	8	40	4
15XΦ	860	780	Water	200	Air	75	55	12	50	8
20XΦ	880		Water or oil	500	Water or oil	80	60	12	50	8
40XΦA	880		Oil	650	Water or oil	90	75	10	50	9
50XΦA	860		Oil	475	Water or oil	130	110	10	45	
20XM	880		Water or oil	500	Water or oil	80	60	12	50	9
30XM	880		Oil	560	Water or oil	85	75	11	45	8
30XMA	880		Oil	560	Water or oil	95	75	12	50	9
35XM	850		Oil	560	Water or oil	95	80	11	45	7
35XMA	850		Oil	560	Water or oil	95	80	12	50	8
35X2MA	870		Oil	620	Water or oil	105	90	8	45	8
33XC	920		Water or oil	630	Water or oil	85	65	13	50	8
37XC (40CX)	900		Oil	630	Oil	90	70	12	50	7
40XC	900		Oil	540	Oil	125	105	12	40	5

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